A remote control apparatus and a receiver and an audio system

Technical Field

The invention relates to a remote control apparatus, a receiver and an audio system and, in particular, to a remote control apparatus that is capable of operating and adjusting the said multi-channel receiver and to a receiver that is capable of outputting multi-channel sounds as well as an audio system that comprises the said receiver and the said remote control apparatus.

Background of the Invention

In setting up an amplifier or a receiver used for an audio-visual (AV) system, such AV system typically uses five speakers, which are to be placed at the front right, front center, front left, rear right and rear left sides respectively, as well as a subwoofer for enhancing the bass sound. After the setup, the following adjustments may be required:

(1) Configuration of speakers

In such systems, the following setups are required to regenerate the proper sound field with those five speakers:

(i) set the size (e.g., large/small or existence/absence) of each speaker;

(ii) set the existence/absence of the subwoofer;

(iii) set the value of the distance from each speaker to the listening position; and

(iv) adjust the balance of the sound volume for each speaker.

As for the above items (i) to (iv), the listener may input respective setting values or existence/absence indications serially in accordance with the setting menus on the amplifier or the receiver. In particular, as for the items (i), (iii) and (iv), the settings are required for each of the five speakers.

(2) Setup of the listening position (adjustment of the sound volume balance when the listening position is changed)

Since it is desirable for the listener to listen to the music or watch the movie in the center between the left and right speakers, the sound volume balance is usually pre-adjusted to the state in which the listener takes a position in the center. However, if the listener changes his or her position to any other position than the center, a further adjustment of the sound volume

balance may be required because the sound volume balance has become inappropriate due to the listening position change.

(3) Adjustment of the room acoustic condition

Under the usual environment surrounding the listener, such phenomena can often occur that a particular frequency of the sound from the speakers tends to be reflected, diffracted and absorbed with the influence of the windows and/or furnishings. Accordingly, although a flat frequency characteristic is output from the amplifier or speakers, the frequency characteristic at the listener position may represent somewhat ups and downs. Therefore such adjustment may be required as to gain a flat frequency characteristic at the listener position by means of adjustment of the graphic equalizer.

As for the configuration of speakers in the above item (1), the procedures and the setting items are usually too many, troublesome and not easy for listeners. Accordingly, if the listener, for example, watches the movie without an appropriate setup, there may exist such problem that the listener cannot gain the proper sound field.

Besides, as for adjustment of the sound volume balance in the above item (2), listeners have been conventionally requested to operate the remote control unit at the listening position to adjust the sound volume balance while he or she is actually hearing the sound with his or her ears. Accordingly, whenever the listener changes his or her listening position, he or she has to make a further adjustment, which may be troublesome to the listener.

Moreover, as for the adjustment of the room acoustic condition in the above item (3), conventionally, it has been difficult for the listener to adjust the frequency characteristic exactly so as to make it flat because the listener should have made such adjustment based on his or her perception with his or her ears. Also, because the variation of frequency characteristic is caused by the sound reflection, diffraction and absorption against the window and/or interior furnishings, the listener has to make a room acoustic adjustment whenever the listener changes his or her listening position.

The invention is to address the above-stated problems. Thus it is an objective of the invention to realize a remote control apparatus and a receiver that are capable of automatically performing various setups, adjustments and corrections for the receiver in an audio system having a plurality of speakers.

Summary of the Invention

The invention achieves the above-stated objective as follows:

(1) The invention provides a remote control apparatus capable of operating and adjusting a multi-channel receiver. The said remote control apparatus is characterized in that the said remote control apparatus comprises transmitting means for transmitting data to the said receiver, a microphone for receiving the sound outputted from the said receiver and arithmetic operating means for calculating the state of the said receiver from the said sound received by the said microphone and analyzing an adjustment value for the said receiver based on a calculation result and that the said transmitting means transmits data for initiating adjustment for the said receiver and transmits an analysis result obtained by the said arithmetic operating means. This remote control apparatus first transmits the data for initiating the adjustment for the receiver, then uses the microphone to receive the sound from the receiver, and transmits back to the receiver the analysis result obtained through the calculation upon the received sound by the arithmetic operating means. With such structure, it becomes possible to automatically perform various setups, adjustments and corrections for the receiver in the audio system having and using a plurality of speakers.

(2) The inventive remote control apparatus as disclosed in the above (1) is further characterized in that the state of the receiver is at least one of a distance from a speaker to the remote control apparatus, a frequency characteristic or a sound pressure level. Thus, this inventive remote control apparatus is configured to send to the receiver at least one of a distance from a speaker to the remote control apparatus (namely the listening position), a frequency characteristic and a sound pressure level as the analysis result obtained by the arithmetic operating means, so that it becomes possible, in the audio system using a plurality of speakers, to automatically perform various setups, adjustments and corrections in terms of at least one of the distance from a speaker to the listening position, the frequency characteristic and the sound pressure level.

(3) The inventive remote control apparatus as disclosed in the above (1) or (2) is further characterized in that the remote control apparatus comprises two microphones. Provision of the two microphones can generate the equivalent effect as dummy heads, so that it becomes possible to make a measurement under the approximately same condition as the real environment.

(4) The inventive remote control apparatus as disclosed in the above (1) or (2) is further characterized in that the remote control apparatus additionally comprises an apparatus main body, first and second microphones arranged to a front portion of said apparatus main body, first and second rotation holding plates which respectively hold said first and second microphones and to which partial gear portions that can be engaged with

each other are formed and a swiveling knob which engages with at least one of said first and second rotation holding plates to give a swiveling force thereto. In particular, the first and second rotation holding plates are pivoted to the apparatus main body such that the plates engage with each other to swivel in opposed directions. Thus, with the use of the two microphones that are strongly directional and are supported so as to be substantially pivoted to the apparatus main body, it becomes possible to receive the sound directly from the speakers without any influence of the reflection from the wall and other environmental objects.

(5) The inventive remote control apparatus as disclosed in the above (1), (2) or (3) is further characterized in that the remote control apparatus additionally comprises receiving means for receiving data from the receiver and that the data received by the receiving means from the receiver is referred while the state of the receiver is calculated by the arithmetic operating means. With this receiving means, it becomes possible to make an adjustment for the receiver while keeping the bi-directional communication with the receiver, which may be in turn resulted in more fine and correct adjustments.

(6) The invention further provides a receiver that is operated and adjusted by a remote control apparatus and capable of multi-channel sound outputting. This inventive receiver is characterized in that the receiver comprises receiving means for receiving data from said remote control apparatus and controlling means for controlling sound outputs from respective channels, that the controlling means outputs a predetermined test tone from each channel by receiving at the receiving means data for initiating adjustment from the remote control apparatus, and that the controlling means controls the state of each channel in accordance with an adjustment value by receiving at the receiving means the adjustment value from the remote control apparatus. This inventive receiver outputs the test tone from each channel upon receiving the data for initiating the adjustment from the remote control apparatus, so that the remote control apparatus can receive and analyze the test tone. The receiver finally receives the analysis result from the remote control apparatus. With this structure, it becomes possible to automatically perform various setups, adjustments and corrections for the receiver in the audio system having and using a plurality of speakers.

(7) The inventive receiver as disclosed in the above (6) is further characterized in that the state of the receiver is at least one of a distance from a speaker to the remote control apparatus, a frequency characteristic, or a sound pressure level. Thus, the inventive receiver is configured to receive at least one of the distance from the speaker to the remote control apparatus (namely the listening position), the frequency characteristic or the sound

pressure level as the analysis result obtained by the remote control apparatus, so that it becomes possible, in the audio system using a plurality of speakers, to automatically perform various setups, adjustments and corrections in terms of at least one of the distance from the speaker to the listening position, the frequency characteristic and the sound pressure level.

(8) The inventive receiver as disclosed in the above (6) or (7) is further characterized in that the receiver additionally comprises transmitting means for transmitting data to the remote control apparatus, and that the data required for calculation in the remote control apparatus is transmitted. With this transmitting means on the receiver, it becomes possible to make an adjustment for the receiver while keeping the bi-directional communication with the remote control apparatus, which may be in turn resulted in more fine and correct adjustments for the receiver.

(9) The invention furthermore provides an audio system comprising a remote control apparatus capable of operating and adjusting a multi-channel receiver and a receiver which is operated and adjusted by said remote control apparatus and capable of multi-channel sound outputting. This audio system is characterized in that the remote control apparatus comprises transmitting means for transmitting data to said receiver, a microphone for receiving sound outputted from said receiver and arithmetic operating means which calculates the state of said receiver from the sound received by said microphone and analyzes an adjustment value for said receiver from a calculation result, that the receiver comprises receiving means for receiving data from said remote control apparatus and controlling means for controlling sound outputs for respective channels, that the controlling means of the receiver outputs a predetermined test tone from each channel by transmitting data for initiating adjustment for the receiver from the transmitting means and receiving data for initiating adjustment by the receiving means, and transmits an analysis result obtained by the arithmetic operating means from the transmitting means to the receiver, and that the controlling means controls the state of each channel in accordance with an adjustment value received by said receiving means.

The receiver within this inventive audio system outputs the test tone from each channel upon receiving the data for initiating the adjustment from the remote control apparatus so that the remote control apparatus can receive and analyze the test tone. The receiver finally receives the analysis result from the remote control apparatus. With this structure, it becomes possible to automatically perform various setups, adjustments and corrections for the receiver in the audio system using a plurality of speakers.

(10) The inventive audio system as disclosed in the above (9) is further characterized in that the state of the receiver is at least one of a distance from a speaker to the remote control apparatus, a frequency characteristic, or a sound pressure level. Thus, it becomes possible, in the audio system using a plurality of speakers, to automatically perform various setups, adjustments and corrections in terms of at least one of the distance from each speaker to the listening position, the frequency characteristic and the sound pressure level.

(11) The inventive receiver as disclosed in the above (9) or (10) is further characterized in that the receiver additionally comprises transmitting means for transmitting data to the remote control apparatus, and that the data required for calculation in the remote control apparatus is transmitted. With this transmitting means on the receiver, it becomes possible to make an adjustment for the receiver while keeping the bi-directional communication with the remote control apparatus, which may be in turn resulted in more fine and correct adjustments for the receiver.

Brief Description of the Drawings

Figure 1 is a schematic diagram illustrating the electric structure of the audio system in accordance with the first embodiment of the invention;

Figure 2 is a schematic diagram illustrating the structure of the placement of each of the components of the audio system in accordance with the embodiment of the invention;

Figure 3 is an operational flow chart for the first embodiment of the invention;

Figure 4 is a schematic diagram illustrating the electric structure of the audio system in accordance with the second embodiment of the invention;

Figure 5 is a schematic diagram illustrating the electric structure of the audio system in accordance with the third embodiment of the invention;

Figure 6 is a schematic illustration of the remote control apparatus used in the third embodiment of the invention; and

Figure 7 is a schematic illustration of the remote control apparatus, partially containing a notch, used in the fourth embodiment of the invention.

Detailed Description of the Invention

[First embodiment]

Figure 1 schematically illustrates an audio system 100 that comprises a receiver 100 and a remote control apparatus 300. As shown in Fig. 1, five speakers 201, 202,

203, 204 and 205 and a subwoofer 206 are connected to the receiver 100. The receiver in Fig. 1 is such receiver that can be operated and adjusted by the remote control apparatus 300 as described later in detail and can output multi-channel sounds. The receiver 100 is configured to have a CPU 101 as a controller for controlling the sound output of each channel and each of the system components, an operation portion 102 for receiving various operation inputs, a display portion 103 for displaying various kinds of status, a receiving portion 105 for receiving the data in electromagnetic waves or infrared radiations from the remote control apparatus, a digital signal processor (DSP) 106 for performing various acoustic processes based on the instruction from the CPU 101 and an amplifier 107 for amplifying audio signals of multi-channels under the control of the CPU 101 and the DSP 106.

Besides, the remote control apparatus 300 is to perform remote operations and adjustments for the receiver 100. This remote control apparatus 300 is configured to have a CPU 301 as a controller for controlling each of the system components, an operation portion 302 for receiving various operation inputs, a display portion 303 for displaying various kinds of status, a transmitting portion 304 for transmitting the data in electromagnetic waves or infrared radiations to the receiver 100, a microphone 306 as a sound-to-electric converter for generating sound signals in response to its detection of the sounds from the speakers and an A/D converter 307 for converting the electric signals generated by the microphone 306 to the digital data.

The CPU 301 is also configured to have a spectrum analyzer 301a for analyzing frequency elements of the sounds received by the microphone 306, a calculation portion 301b for calculating the output state of the receiver 100 from the sounds received by the microphone 306 and an analyzing portion 301c for analyzing adjustment values for the receiver 100 from the result of the calculation by the calculating portion 301b. The calculation portion 301b and the analyzing portion 301c together comprise an arithmetic operation means. Moreover, the frequency characteristic of the microphone 306 is preferably flat and non-directional.

It should be noted that although the spectrum analyzer 301a, the calculation portion 301b and the analyzing portion 301c are integrated within the CPU 301 in the first embodiment shown in Fig. 1, they can be disposed as separate circuits. Besides, the spectrum analyzer 301a may be an analog processing circuit as an alternative.

Figure 2 illustrates an arrangement of the components of the audio system in a listening room, where speakers 201-206 are placed so as to form 5.1 channels. A speaker 201 is a front left one (L), 202 is a front right one (R), 203 is a front center one (C), 204 is a rear

left one (SL), 205 is a rear left one (SL) and 206 is a subwoofer (Sub) respectively. The receiver 100 is placed near to the center speaker 203, and the remote control apparatus is placed at the listening position for the listener to easily operate it.

Now referring to Figure 3, the operation of the audio system comprising the receiver 100 and the remote control apparatus 300 will be below explained. Assume that the receiver 100 in the listening room 400 has been already powered on, that the connection between the receiver 100 and the speakers 201-205 has been already established, and that the remote control apparatus 300 is being kept by the listener at the listening position. In this situation, the remote control apparatus may be transited from a normal mode to a setup mode (in start setup step in Fig. 3) by the listener's operation of depressing the "setup" button (not shown herein) mounted at the operation portion 302 of the remote control apparatus 300.

The remote control apparatus 300, after having been transited to the setup mode, may transfer the data, in accordance with the instruction of the CPU 301, from its transmitting portion 304 to the receiver 100 for initiating an adjustment of the receiver 100 (step S11). Then, the receiver 100 may receive that setup data from the remote control apparatus 300 at its receiving portion 105 to perform the required system setup with the assistance of the CPU 101 (step S21). The CPU 101 of the receiver 100 may output a series of the predetermined test tone signals from each of the channels (step S22). In particular, the CPU 101 may control each of the speakers, for example, in a sequence of L, C, R, SR, SL and Sub, to output a pink noise of pulse having a certain frequency and a certain sound pressure with a predetermined timing interval through the amplifier 107.

Then, test tone signals may be received by the microphone 306 of the remote control apparatus 300 and delivered to the CPU 301 after having been converted to the digital data by the A/D converter 307 (step S12). Thereafter, the CPU 301 of the remote control apparatus 300 may calculate a state of the receiver output, a state of the listening room and states of each of the speakers based on the digital data received by the microphone 306. In other words, the spectrum analyzer 301a and the calculating portion 301b of the CPU 301 may cooperate to calculate a distance from each speaker to the remote control apparatus (namely the listening position), a frequency characteristic and a sound pressure level (step S13).

Then, the analyzing portion 301c may analyze adjusting values from the calculation result by the calculating portion 301b. In particular, such analysis may include:

- whether the sound pressure of each speaker is all in an equivalent level at the listening position or not, or which channel(s) and what degree should be adjusted so as to make all sound pressures equal;
- determining the size (large or small) of each speaker based on the distribution of frequency characteristics; and
- analyzing what time difference each sound from each speaker has reached the listening position with, so as to calculate the distances from respective speakers to the listening position.

Then, the CPU 301 of the remote control apparatus 300 may transmit such analysis result from the transmitting portion 304 to the receiver 100 (step S15), so that the receiver 100 may receive the analysis result from the remote control apparatus 300 at its receiving portion 105. Accordingly, the CPU 101 of the receiver 100 can perform various adjustments required to set up the speakers (speaker configuration) based on the analysis result (step S24). It is particularly desirable for the CPU 101 to return to the step S22 for outputting the test tone again to assure that the receiver has been adjusted so as to be in the desired state. If required, a further adjustment may be performed (steps S24 to S22). Finally, the remote control 300 and the receiver 100 may complete the setup mode and transit back to the normal mode (setup end).

The operation just explained above was in conjunction with the setup of the speaker configuration. In case of the listening position setup in response to the change of the listening position, the remote control apparatus 300 may be transited from a normal mode to a listening position setup mode by the listener's operation of depressing the "level set" button (not shown herein) mounted at the operation portion 302 of the remote control apparatus 300. In this situation, some required adjustments for the sound pressures for each speaker may be automatically performed according to the same procedure as explained above.

Also, as for the room acoustic adjustment to adjust the inappropriate frequency characteristics due to reflection, diffraction, absorption and so on in the listening room, the remote control apparatus 300 may be transited from a normal mode to a room acoustic adjustment setup mode by the listener's operation of depressing the "acoustic" button (not shown herein) mounted at the operation portion 302 of the remote control apparatus 300. In this situation again, it is possible to automatically perform some required adjustments for obtaining the flat frequency characteristic of each speaker according to the same procedure as explained above.

In accordance with the embodiment as explained above, it is possible to automatically perform some setup, adjustments and corrections for the receiver in the audio system using a plurality of speakers without any complicated and troublesome operation by the listener.

[Second embodiment]

Figure 4 illustrates an audio system comprising a receiver 100 and a remote control apparatus 300 in accordance with the second embodiment of the invention, where the same code numbers are given to the equivalence as those in Figure 1. Such equivalence will not be described in the following to avoid duplication.

Within the second embodiment, the receiver may additionally comprise a transmitting portion 104 for transmitting the data to the remote control apparatus 300, and the remote control apparatus 300 may also additionally comprise a receiving portion 305 for receiving the data from the receiver 100.

With this structure, the receiver 100 and the remote control apparatus 300 together could transmit and receive the data each other to perform adjustments. Thus, it becomes possible to make more fine and exact adjustments through such bi-directional communications between the receiver 100 and the remote control apparatus 300.

In particular, in the third embodiment, it is possible for the receiver 100 to send the data required for the calculation to be performed at the side of the remote control apparatus 300 through the communication with the remote control apparatus 300. Besides, because of the bi-directional communication, it becomes possible to display such information as adjustment progress status, components to be adjusted and adjustment completion event not only on the display portion 1103 of the receiver or the TV screen (on-screen-display) that is to be connected to the receiver 100 but also on the display portion 303 of the remote control apparatus 300 near the listener.

In addition, the second embodiment may be applied to store, as a learnable remote control, signals of some remote control units supplied from other manufacturers with the receiving portion 105 of the remote control apparatus 300. Moreover, it may be possible for the user to easily locate the remote control apparatus 300 by recognizing some blinking or beeping event issued from the remote control apparatus 300 in response to reception (at its receiving portion 305) of the data transmitted from the transmitting portion 104 of the receiver only if the user pushes a certain button on the operation portion 102 of the receiver 100.

[Third embodiment]

Figure 5 illustrates an audio system comprising a receiver 100 and a remote control apparatus 300 in accordance with the third embodiment of the invention, where the same code numbers are given to the equivalence as those in Figure 1 and/or Figure 4. Such equivalence will not be described in the following to avoid duplication.

Within the third embodiment, the remote control apparatus 300 comprises two microphones 306a and 306b instead of one microphone 306 in the first and second embodiments. The remote control apparatus 300 also comprises two A/D converters 307a and 307b that are configured to respectively convert signals from each of the two microphones 306a and 306b to supply converted signals to the CPU 301.

Figure 6 illustrates the appearance of the remote control apparatus 300 in accordance with the third embodiment. In particular, on the upper surface of the body portion of the remote control apparatus 300, there are provided the operation portion 302, a group of setup buttons 302a (not show herein) usually covered with a cover and a LCD display portion 303. Besides, on the front side of the body portion of the remote control apparatus 300, there are provided an infrared LED 304d for transmitting the data and a photodiode 305d for receiving the data. The remote control apparatus 300 additionally comprises two microphones 306a and 306b that have a relatively wide directivity and are mounted separately each other at the left and right sides respectively on the front side of the main body.

With such separate arrangement of the two microphones on both left and right sides of the main body of the remote control apparatus 300, it may be possible to gain the equivalent effect as in case of dummy heads, so as to collect and measure the test tone under the approximately same condition as the real environment of the listener. It is also possible to collect the test tone in all ranges including the rear side by using the two microphones having the relatively wide directivity.

Alternatively, the two microphones 306a and 306b may be mounted on the respective side faces of the main body of the remote control apparatus 300 rather than on the left and right portions of the front side as illustrated in Fig. 6. It should be noted that the configuration of this third embodiment in Fig. 5 contains the bi-directional communication facility in the same manner as in the second embodiment but it may include only a unidirectional facility as in the first embodiment.

[Fourth embodiment]

Figure 7 illustrates a remote control apparatus 300, which is configured to partially include a notch, in accordance with the fourth embodiment of the invention, where

the same numbers are given to the equivalence as those in Figure 6. Such equivalence will not be described in the following to avoid duplication.

On the upper surface of the main body of the remote control apparatus 300, there are provided two microphones 306a and 306b for collecting the monitor sounds as test tones as illustrated in Fig. 7. These two microphones 306a and 306b are held by rotation holding plates 311 and 312 respectively. The rotation holding plates 311 and 312 comprise respective partial gear portions (not shown herein) that have the same diameter and can be engaged with each other. The rotation holding plates 311 and 312 are supported with a cage member (not show herein) of the main body in such manner that those partial gear portions are engaged with each other. In addition, on the remote control apparatus 300, there are provided a small gear 313 that is pivoted to the main body so as to be engaged with the partial gear portion of the rotation holding plate 311 and also an operation knob (not shown herein) to be integrated with the small gear 313.

With such configuration of the remote control apparatus 300, when the operation knob is handled to rotate the small gear 313, which is configured to be coaxial with the operation knob, toward the arrow A as shown in Fig. 7, the rotation holding plate 311 will be correspondingly rotated toward the opposite direction against the arrow A while the rotation holding plate 312 will be correspondingly rotated toward the same direction as the arrow A. At this time, the rotation holding plates 311 and 312 together are rotated with the equal angle amount toward the open direction because the diameters of both plates are in the equal size.

Thus, when the operator aims the remote control apparatus 300 toward a speaker as a sound source and handles the operation knob, the rotation holding plates 311 and 312 will be rotated so that both of the microphones held with the respective rotation holding plates can move by the equal rotation amount toward either open or close direction and receive the test tone from the opposite sound source in the approximately perpendicular direction. In other words, it is possible for the microphones, if they are strongly directional, to selectively receive the test tone sounds from a plurality of the sound sources in the almost same condition as in the case where the listener hears the sound with a pair of ears.

It should be noted that although the diameters of the partial gears of the rotation holding plates 311 and 312 are equal in the remote control apparatus 300 in accordance with the forth embodiment, each of the diameters may be preferably selected in accordance with the overall design specification, and the degree to open or close the axial

lines of the microphones 306a and 306b by means of the operation knob may be also preferably selected in accordance with the system usage environment.

Furthermore, the remote control apparatus 300 may be configured such that the rotation of the small gear 313 could be driven by means of a motor, the test tone output from the opposite sound source could be of linearity and high frequency (e.g. 5 kHz and more), and the degree to open or close the axial lines of the microphones 306a and 306b could be automatically adjusted to take such position as to receive the maximum amount of the test tone. With such configuration, the output level of the opposite sound source could be adjusted based on the test tone. This configuration allows for the listening position to be exactly adjusted through the use of the microphones having strong directionality.

It should be further noted that although the microphones 306a, 306b as above described are configured to be rotated with the equal angle amount, they may have respective different rotation angles by providing separate rotation knobs and/or separate motor drives. With such different angles, it may be possible to selectively receive a plurality of the sound sources even if the listening position may be one-sided to either right or left direction from the center of the listening room 400.

Consequently, in accordance with the invention as above described, it is possible to realize the audio system comprising the remote control apparatus and the receiver which can automatically perform setups, adjustments and corrections for the receiver within the audio system using several speakers.